United States Patent Application

for

FIXED ABRASIVE CMP PAD DRESSER AND ASSOCIATED METHODS

TO THE COMMISSIONER OF PATENTS AND TRADEMARKS:

CHIEN-MIN SUNG, citizen of the United States, whose post office address is **No. 4, Lane 32, Chung-Cheng Road, Tansui, Taipei County, Taiwan Province, R.O.C. 23911** prays that letters patent may be granted to him as inventor of **FIXED ABRASIVE CMP PAD DRESSER AND ASSOCIATED METHODS** as set forth in the following specification.

FIELD OF THE INVENTION

The present invention relates to devices and methods for use in connection with fixed abrasive chemical mechanical polishing or planarization (CMP) pads. More particularly, the present invention relates to tools for use in dressing or conditioning fixed abrasive CMP pads, and accompanying methods for the making and design thereof.

BACKGROUND OF THE INVENTION

CMP has become a widely used technique for removing material from a workpiece. The computer manufacturing industry, especially, has begun to rely heavily on CMP processes for polishing wafers of various materials, including ceramics, silicon, glass, quartz, metals, and mixtures thereof for use in semiconductor fabrication. Generally, the polishing process entails applying a wafer against a flat horizontally-rotating pad, often porous or fibrous, made from a durable organic substance such as polyurethane. To the rotating pad, is added a slurry containing a chemical solution and abrasive particles. The chemical solution is capable of chemically reacting with the wafer substance, and abrasive particles help the pad physically polish the wafer surface. The slurry is continually added to the spinning CMP pad, and the dual chemical and mechanical forces exerted on the wafer cause it to be polished in a desired manner.

During the course of polishing, the pores or fibers of the CMP pad become clogged with debris abraded off the workpiece, the pad, and with an over abundance of abrasive particles from the slurry. Such accumulation causes glazing or hardening of the pad, and reduces its capacity to effectively remove material from the workpiece. Therefore, a CMP pad of this type is typically "dressed" or "conditioned" using a CMP

pad dresser or conditioner. A variety of such conditioners, including specific methods for the use and manufacture thereof, are known in the art.

In general terms, the CMP pad dresser is a round flat disk having a plurality of diamond particles, or other particles, protruding out of a substrate. Examples of specific CMP pad dresser configurations and methods for the manufacture thereof, may be found in Applicant's co-pending United States Patent Applications Serial Nos. 09/558,582, and 09/687,444, each of which is incorporated herein by reference in its entirety. In use, the working surface of the disk is pressed against the polishing surface of the CMP pad while either the pad, or the disk, or both, are rotated. As such, the diamond particles of the dresser protrude into the pad and remove debris, as well as lift matted pad fibers, and create new grooves to hold additional abrasives. Thus the pad is rejuvenated, and able to maintain its polishing performance.

While pads utilizing a slurry have been effective in achieving a wide variety of polishing configurations, such pads suffer various drawbacks such as abrasive particle aggregation. Particularly, due to the centrifugal force of the horizontally spinning CMP pad, the loose abrasive particles from the slurry tend to group, or gather, in the more shallow regions of the pad. Thus, when used to polish certain materials, such as softer metals, uneven depressions known as "dishing" can occur. Additionally, because the abrasive particles are not physically attached to the pad, but rather are free moving, it is difficult to increase the rate of material removal from a workpiece by simply increasing the speed of the pad's rotation.

In order to solve these and other problems, CMP pads which include abrasive particles that are embedded in, or otherwise fixed to, the pad, rather than provided in a

slurry, have become known in the art, such as those disclosed in U.S. Patent Nos. 5,453,312, 5,454,844, 5,692,950, and 5,820,450, each of which are incorporated herein by reference. A chemical solution is still typically used with such fixed abrasive pads. However, because the abrasives are embedded in the pad, a slurry which contains abrasive particles is not needed.

Additionally, while traditional CMP pads have a substantially flat fibrous or porous polishing surface, as shown in FIGS. 1 and 2, the polishing surface of a fixed abrasive pad contains a plurality of small projections known as "poles". The amount of surface which is covered by poles is known as the "loading ratio," and may vary depending on the application. Generally each pole has a size of about 200 microns in diameter and about 30 microns in height, however, specific size may vary somewhat depending on the particular needs of a specific polishing application. Typically, because the poles may be manufactured to a uniform height above the polishing surface, fixed abrasive CMP pads are capable of achieving a superior flat surface on a workpiece as compared to conventional CMP pads.

Unfortunately, fixed abrasive pads have a short lifespan before they become dull and functionally unusable. A variety of reasons may account for this, including the wearing of poles, and the build up of debris from the workpiece which clogs the spaces between the poles. Although, conventionally designed CMP pad dressers are well suited for conditioning conventional CMP pads, they have been found to be unusable in conditioning fixed abrasive pads. Specifically, conventional dressers have been found to dislodge the abrasive particles of the fixed abrasive pad, as well as damaging or

dislodging the poles themselves. Such damage renders the polishing pad unusable, and may often scar the polished surface of the workpiece.

As such, devices and methods for dressing or conditioning fixed abrasive type CMP pads which effectively condition the pad without damaging it, continue to be sought through on-going research and development efforts.

SUMMARY OF THE INVENTION

Accordingly, the present invention provides a dressing tool suitable for conditioning a fixed abrasive CMP pad. In one aspect, the dressing tool may include a substrate having a working surface with a plurality of small projections.

Various aspects of the small projections, such as height, width, geometric shape, and organization, may be varied in order to achieve a particular result, or accommodate certain needs of the fixed abrasive CMP pad to be conditioned. For example, in one aspect, the small projections may each have a height which is about equal to or less than the height of the poles contained on a fixed abrasive CMP pad to be conditioned. In a more detailed aspect, the projections may each have a height of less than about 30 micrometers. Further, the projections may take a wide variety of geometric shapes, including without limitation, poles, cones, pyramids, bumps, spikes, etc.

The organization and placement of the projections may be in accordance with a number of patterns as required in order to achieve a specific result. In one aspect, the projections may be spaced apart from one another for a distance of less than about 150 micrometers. Further, while such individual aspects of height and spacing may be varied in numerous ways to achieve a desired pattern or effect, in yet a more detailed aspect of

the invention, the height or spacing, or both of the projections may be uniform

The substrate and projections of the dressing tool may be made from a variety of materials, including ceramic and metallic materials. Examples of suitable ceramic materials include without limitation, aluminum oxide, silicon oxide, zirconium oxide, silicon carbide, zirconium carbide, silicon nitride, boron nitride, zirconium nitride, and mixtures thereof. Examples of metallic materials include without limitation titanium, chromium, steel, stainless steel, titanium, tungsten, and alloys thereof.

In addition to the above-recited elements, the dressing tool of the present invention may additionally include a carbonaceous layer formed over the working surface of the substrate and projections. Such a carbonaceous layer generally imparts both durability and additional anti-corrosive properties to the dressing tool. While a wide variety of carbonaceous materials may be used, in one aspect, the carbonaceous material may be diamond, polycrystalline diamond, diamond-like carbon, or a mixture thereof. In another aspect, the diamond-like carbon may be amorphous diamond, and may contain hydrogen. Such materials may be deposited or grown on the working surface using a number of well known deposition techniques, such as chemical vapor deposition (CVD) and physical vapor deposition (PVD).

The parameters, such as thickness, etc. of the carbonaceous layer may vary, however, in one aspect, the layer of carbonaceous material may have a thickness of from about 0.1 micrometer to about 10 micrometers. Further, as is more fully described below, the specific ornamentation of the carbonaceous layer's working surface may inversely correspond to the interface surface of an ephemeral mold. As such, a dressing tool fabricated using an ephemeral mold to form the working surface thereof, may include a

substrate, and a carbonaceous layer coupled to the substrate, wherein the carbonaceous layer has a working surface with plurality of small projections thereon, which inversely corresponding to an interface surface of the ephemeral mold, from which the carbonaceous layer was formed.

The present invention additionally encompasses methods for making the dressing tools as disclosed herein. According to one embodiment, a method of making a dressing tool includes the steps of providing a substrate having a working surface, and forming a plurality of small projections on the working surface. Such a method may further include the step of forming a carbonaceous layer over the working surface. Alternatively, according to another embodiment, a method of making a dressing tool may include the steps of providing a mold having an interface surface with a plurality of small concavities inversely matching a plurality of small projections intended for a working surface of the tool, growing a carbonaceous layer on the interface surface using a deposition technique, coupling the carbonaceous layer to a substrate, and removing the mold to expose the working surface.

The present invention further includes a method for conditioning or dressing a fixed abrasive CMP pad dresser. In one aspect, such a method includes the steps of providing a dressing tool as disclosed herein, and applying the working surface thereof against a polishing surface of the fixed abrasive CMP pad during rotation thereof. Such a method may further include the step of rotating the dressing tool during application thereof to the fixed abrasive CMP pad.

There has thus been outlined, rather broadly, the more important features of the invention so that the detailed description thereof that follows may be better understood, and

so that the present contribution to the art may be better appreciated. Other features of the present invention will become clearer from the following detailed description of the invention, taken with the accompanying drawings and claims, or may be learned by the practice of the invention.

Brief Description of the Drawings

FIG. 1 is a cross-sectional view of one configuration for a fixed abrasive CMP pad made in accordance with the prior art.

FIG. 2 is a cross-sectional view of another configuration for a fixed abrasive CMP pad made in accordance with the prior art.

FIG. 3 is a cross-sectional view of a dressing tool made in accordance with one embodiment of the present invention.

FIG. 4 is a cross-sectional view of a dressing tool with a carbonaceous layer in accordance with one embodiment of the present invention.

FIGS. 5a-d respectively, are cross-sectional views of various steps in the formation of a dressing tool in accordance with one embodiment of the present invention.

Detailed Description

Before the present invention is disclosed and described, it is to be understood that this invention is not limited to the particular structures, process steps, or materials disclosed herein, but is extended to equivalents thereof as would be recognized by those ordinarily skilled in the relevant arts. It should also be understood that terminology employed herein is used for the purpose of describing particular embodiments only and is not intended to be

limiting.

It must be noted that, as used in this specification and the appended claims, the singular forms "a," and, "the" include plural referents unless the context clearly dictates otherwise. Thus, for example, reference to "a diamond particle" includes one or more of such particles, reference to "a carbon source" includes reference to one or more of such carbon sources, and reference to "a CVD technique" includes reference to one or more of such CVD techniques.

Definitions

In describing and claiming the present invention, the following terminology will be used in accordance with the definitions set forth below.

As used herein, "super hard" and "superabrasive" may be used interchangeably, and refer to any crystalline, or polycrystalline material, or mixture of such materials which has a Moh's hardness of about 8 or greater. In some aspects, the Moh's hardness may be about 9.5 or greater. Such materials include but are not limited to diamond, polycrystalline diamond (PCD), cubic boron nitride, polycrystalline cubic boron nitride (PCBN) as well as other ceramic materials known to those skilled in the art. Super hard materials may be incorporated into the present invention in a variety of forms including particles, grits, films, layers, etc.

As used herein, "fixed abrasive pad," and "fixed abrasive CMP pad," and "fixed abrasive polishing pad" may be use interchangeably and refer to a chemical mechanical polishing, or planarization pad which has a plurality of poles formed thereon, and has plurality of abrasive, or superabrasive particles embedded therein, or otherwise attached thereto. A number of such pads are well known in the art including the pads contained in the

references enumerated in the background section above.

As used herein, "projections" refers to any structure which by design, is raised or protrudes above the working surface of a CMP pad dresser. Projections useful in the present invention may take a wide variety of geometric configurations, including without limitation, cylinders, columns, bumps, mounds, pyramids, spikes, cubes, cones, etc. and may be arranged in a variety of patterns.

As used herein with respect to projections, "height" refers to the distance between a distal most point of a projection and a proximal most point of a projection. This same definition applies when the word "height" is used with respect to poles.

As used herein with respect to projections, "small" refers to projections having a size that is sufficient to properly condition or dress a fixed abrasive CMP pad, without substantially damaging or dislodging the poles thereof. In one aspect, a "small" projection may be a projection having a height less than that of the poles on a fixed abrasive CMP pad to be dressed. In another aspect, the height of a "small" projection may be less than about 30 micrometers.

As used herein, "metallic" refers to a metal, or an alloy of two or metals. A wide variety of metallic materials are known to those skilled in the art, such as aluminum, copper, chromium, iron, steel, stainless steel, titanium, tungsten, zinc, zirconium, molybdenum, etc., including alloys and compounds thereof.

As used herein, "ceramic" refers to a hard, often crystalline, substantially heat and corrosion resistant material which may be made by firing a non-metallic material, sometimes with a metallic material. A number of oxide, nitride, and carbide materials considered to be ceramic and are well known in the art, including without limitation, aluminum oxides, silicon

oxides, boron nitrides, silicon nitrides, and silicon carbides, tungsten carbides, etc.

As use herein, "carbonaceous" refers to a superabrasive material made substantially from carbon. A variety of carbonaceous materials and methods for the production thereof are known to those skilled in the art, including without limitation, diamond, polycrystalline diamond, and diamond-like carbon.

As used herein, "interface surface" refers to the surface of a mold, or ephemeral mold, upon which materials used in the fabrication of a working surface of a substrate or carbonaceous layer are deposited. Such materials include diamond, graphite, or other superabrasive particles, as well as peripheral materials used to facilitate diamond layer growth using a chemical vapor deposition (CVD) or physical vapor deposition (PVD) technique.

As used herein, "working surface" refers to the surface of a tool, which faces toward a workpiece, or performs a friction-involved function during a work process.

As used herein, "inversely corresponds" refers to the inverse relationship between the configuration of a working surface, and the configuration of a mold's interface surface from which the working surface was made, when such surfaces are oriented in the same direction. In other words, when a working surface of a tool is formed at the interface surface of a mold, the configuration of each will inversely correspond to the other when the surfaces are separated and faced in the same direction. In some instances, the inverse correspondence may result in a mirror image.

As used herein, "nucleation side," "nucleation surface," and similar terms may be used interchangeably, and refer to the side or surface of a carbonaceous layer at which nucleation of carbon particles originated. Otherwise described, the nucleation surface of a

carbonaceous layer is the side or surface, which was first deposited upon the interface surface of a mold. In many instances, the nucleation surface may become the working surface of the CMP pad dresser.

As used herein, "growth side," "grown side," and "grown surface" may be used interchangeably and refer to the surface of a carbonaceous film or layer which is grows during a CVD or PVD process.

As used herein, with respect to an ephemeral mold, "concavities," refers to invaginations, depressions, or other concave shapes formed in the interface surface which impart a projection to a working surface formed thereon.

Concentrations, amounts, and other numerical data may be expressed or presented herein in a range format. It is to be understood that such a range format is used merely for convenience and brevity and thus should be interpreted flexibly to include not only the numerical values explicitly recited as the limits of the range, but also to include all the individual numerical values or sub-ranges encompassed within that range as if each numerical value and sub-range is explicitly recited.

As an illustration, a numerical range of "about 1 micrometer to about 5 micrometers" should be interpreted to include not only the explicitly recited values of about 1 micrometer to about 5 micrometers, but also include individual values and sub-ranges within the indicated range. Thus, included in this numerical range are individual values such as 2, 3, and 4 and sub-ranges such as from 1-3, from 2-4, and from 3-5, etc.

This same principle applies to ranges reciting only one numerical value. Furthermore, such an interpretation should apply regardless of the breadth of the range or the characteristics being described.

Invention

As recited above, fixed abrasive CMP pads differ from convention CMP pad by containing a plurality of poles on the polishing surface, and having a plurality of abrasive particles embedded in or otherwise attached to the polishing surface, including the poles. Referring now to FIGS. 1 and 2, there are shown typical fixed abrasive CMP pad dressers such as are known in the prior art. Specifically, each polishing pad 1 has a polishing surface 5 with a plurality of poles 10 affixed thereto, and a plurality of abrasive particles 15 embedded therein. As can be seen, by a comparison of FIGS. 1 and 2, the specific geometric shape of the poles may vary somewhat. Further, the specific pattern in which the poles are formed, their exact size, and the concentration of poles on the polishing surface may also be varied. Generally speaking, however, the poles have a size of about 200 micrometers in diameter, and 30-50 micrometers in height. As will be appreciated by one of ordinary skill in the art, the ability of such a fixed abrasive CMP pad to remove material from a workpiece is largely dependent on maintaining the polishing surface and poles in a clean and undamaged condition.

The present invention provides a dressing tool that is suitable for conditioning fixed abrasive CMP pads without substantially damaging or dislodging the poles thereof. Thus the polishing surface may be cleaned while maintaining its polishing integrity. Referring now to FIG. 3, in one aspect, the dressing tool 20 of the present invention may include a substrate 25, having a working surface 30, with a plurality of small projections 35, formed thereon.

Notably, the dimensions, such as height and diameter of the projections 35 may vary in order to achieve a specific result, or to adequately condition a fixed abrasive pad having a particular configuration or type of poles. However, in one aspect of the present invention,

the projections have a height which is about equal to or less than about the height of the poles on the fixed abrasive pad. In another aspect, the height of the projections may be less than about 30 micrometers in height. In yet another aspect, the projections may be less than about 20 micrometers in height. In a further aspect of the invention, the projections may be less than about 10 micrometers in height. Additionally, while certain configurations may call for projections of different heights on a single pad dresser, in yet an additional aspect of the invention, the projections may have a uniform height.

In addition to such dimension as height and diameter, the placement or positioning of the projections 35 may be varied in a random, uniform, or predetermined pattern in order to accommodate the conditioning requirements of a particular fixed abrasive pad configuration. Parameters, such as spacing between the projections, the over all pattern in which the projections are arranged, and the total number or density of projections on the dressing tool may all be varied. However, in one aspect, the projections are spaced apart for a distance of less than about 150 micrometers. In another aspect, the projections are spaced apart for a distance of less than about 100 micrometers. In yet a further aspect, the projections are spaced apart for a distance of less than about 50 micrometers. In an another aspect of the invention, the projections may be uniformly spaced apart.

While the projections 35 shown in FIG. 3 have a the shape of a pyramid or cone, a wide variety of shapes may be used for the projections of the present invention as required in order to achieve a particular results or more effectively condition a specifically configured fixed abrasive pad. Examples of specific geometric shapes and configurations which are suitable for the projections of the present dressing tool include without limitation, bumps, mounds, cones, pyramids, spikes, prongs, cubes, columns, cylinders, poles, etc. Each of

which may achieve a different result or be more or less useful with various fixed abrasive pads. In one aspect, however, the projections may have a pyramid shape. In another aspect, the projections may have a cone shape.

Referring again to FIG. 3, the substrate 25 and the projections 35 may be made from numerous materials which are sufficiently durable to impart a useful lifespan to the dressing tool including ceramic and metallic materials. In one aspect of the invention, the substrate may be made of an anti-corrosive material that is substantially impervious to degradation from the chemical solution used in connection with a fixed abrasive pad. A variety of metallic and ceramic materials may have such qualities, such as stainless steel and corundum.

In one aspect of the invention, the substrate 25 and projections 35 may comprise, be substantially made of, or consist of a metallic material. Suitable metallic materials may include without limitation, metals such as, copper, titanium, tungsten, tantalum, nickel, zirconium, zinc, vanadium, chromium, steel (refined iron), stainless steel (steel and chromium), as well as alloys thereof.

The substrate 25 and projections 35 may additionally comprise, be substantially made of, or consist of a ceramic material. Nearly any ceramic material that sufficiently meets the hardness and durability requirement demanded of the dressing tool may be used including various silicon containing materials. In one aspect, certain oxide, carbide, and nitride compounds may be used, including without limitation, silicon carbide (SiC), quartz (i.e. crystalline SiO_2), corundum or sapphire (i.e. aluminum oxides such as Al_2O_3), silicon nitride (Si_3N_4), boron nitride (BN) (including cubic boron nitride or cBN), tungsten carbide (WC), titanium carbide (TiC), and zirconium carbide (ZrC), zinc oxide (ZnO), zirconia (ZrO_2),

aluminum nitride (AlN), titanium nitride (TiN), and zirconium nitride (ZrN), as well as mixtures thereof. In one aspect, the ceramic material may be a silicon carbide. In another aspect, the ceramic material may be a cemented tungsten carbide.

Whether the substrate 25 is made of a ceramic material or a metallic material, the working surface 30, including the projections 35 can be formed using a number of techniques known to those of ordinary skill in the art, such as mechanical, electrical, or chemical techniques. By way of example, in a case where the substrate is metallic, the working surface may be machined using a well known Computer Numerical Machine (CNC), or the surface may be prepared by using an Electrical Discharge Machine (EDM). Additionally, when the substrate is made of a silicon or a silicon containing material, the working surface may be chemically prepared using conventional etching techniques, such as lithography. Such techniques are well known to those of ordinary skill in the art, and various other techniques for preparing the working surface that are not mentioned will be readily recognized by those of ordinary skill in the art.

The dressing tool of the present invention may include additional features and components in addition to the basic elements disclosed above. Referring now to FIG. 4, there is shown a dressing tool 20, including a substrate 25, having a working surface 30, with a plurality of projections 35 thereon. Further, a carbonaceous layer 40 is formed or grown over the working surface of the substrate, including the projections. As the carbonaceous layer is now the outermost layer on the dressing tool, it also has a working surface 45 which will contact a fixed abrasive pad during a conditioning procedure. Notably, the anatomy of the projections 35 is transferred from the working surface of the substrate to the working surface of the carbonaceous layer, which now becomes the primary working surface of the

tool.

The thickness of the carbonaceous layer may be any thickness required in order to achieve a particular result. However, in one aspect, the carbonaceous layer may have a thickness of from about 0.1 micrometers to about 10 micrometers. In another aspect, the thickness may be 1 micrometer. Despite the ability to select a desired thickness for the carbonaceous layer, its projections 50, must still meet the size, shape, and other configuration or placement aspects outlined herein.

A number of carbonaceous materials may be used in order to form the carbonaceous layer 40 of the dressing tool of the present invention. Examples of such carbonaceous materials include without limitation, diamond, polycrystalline diamond, diamond-like carbon, and mixtures thereof. In one aspect of the present invention, the carbonaceous layer may be made substantially of polycrystalline diamond. In another aspect, the carbonaceous layer may be made substantially of diamond-like carbon. Such diamond-like carbon may be, amorphous diamond, and may further include hydrogen.

The carbonaceous layer 40 may be made or grown by any method known to those of ordinary skill in the art for making such a carbonaceous layer. Examples of such methods include without limitation, chemical vapor deposition (CVD) and physical vapor deposition (PVD), including but not limited to hot filament, microwave plasma, oxyacetylene flame, and direct current arc techniques. However, in one aspect, a layer of diamond-like carbon may be grown using PVD.

Such techniques are well known to those of ordinary skill in the art. Further, the specific technique employed may be selected using the knowledge of one ordinarily skilled in the art depending on such factors, as the specific type of carbonaceous layer to be formed and

the particular material of the substrate 25 and projections 35.

The present invention additionally includes methods for the fabrication and use of the dressing tools disclosed herein. In one aspect, a method for making a dressing tool that is suitable for conditioning a fixed CMP pad includes the steps of providing a substrate having a working surface, and forming a plurality of small projections on the working surface. As recited above, a variety of chemical, electrical, and mechanical methods known to those of ordinary skill in the art may be used in preparing the working surface and forming the plurality of small projections. Further, such projections may be formed according the shape, size, and placement parameters described herein.

In one aspect of the present invention, the method of making a dressing tool as recited above may further include the step of forming a carbonaceous layer on the working surface of the dressing tool. As indicated above, a variety of CVD and PVD techniques known to those of ordinary skill in the art may be used to form the carbonaceous layer.

In an alternative aspect of the present invention, the carbonaceous layer may be formed first, including the projections thereof. Following formation of the carbonaceous layer, the substrate is then coupled thereto in order to produce the final dressing tool. Formation of a carbonaceous layer in such a manner requires the use of an ephemeral mold having an interface surface which contains a design or pattern that is the inverse of the configuration to be transferred to the working surface of the carbonaceous layer.

In one aspect of the present invention, such a method includes the steps of providing a mold having an interface surface with a plurality of small concavities inversely matching a plurality of small projections intended for a working surface of the tool, growing a carbonaceous layer on the interface surface using a deposition technique, coupling the

carbonaceous layer to a substrate, and removing the mold to expose the working surface. Notably, even when using such a method, the parameters concerning the size, shape, and placement of the projections as described herein must be adhered to. Further, the deposition techniques recited above for making a carbonaceous layer may be employed in this method as well as the method set forth above.

Referring now to FIGS. 5a-5d, there is shown one example of various points in the process for making a dressing tool in accordance with a method wherein the carbonaceous layer is formed apart from the substrate and then subsequently joined thereto. FIG. 5a shows a mold 55 made of a suitable material, having an interface surface 60 configured with a plurality of concavities 65. The mold may be made of a variety of metallic or ceramic materials which are suitably durable to withstand the conditions of CVD or PVD growth of a carbonaceous layer thereon, such as those materials recited above for the substrate. FIG.5b shows a carbonaceous layer 40 deposited upon the interface surface of the mold, using a deposition technique.

Referring now to FIG. 5c, there is shown a substrate 25, which has been joined to the carbonaceous layer 40. Specifically, in the embodiment shown, the substrate and carbonaceous layer are joined by an adhesive or resin type layer 70, such as an epoxy. A wide variety of suitable materials for attaching the carbonaceous layer to the substrate, will be readily recognized by those of ordinary skill in the art, such as brazing, adhesives, etc.

Either subsequent or prior to the attachment of the substrate 25 to the carbonaceous layer 40, the mold 60 may be removed by a process suitable to the type of material from which the mold is made, such as chemical dissolution with a strong acid, etc. Removal of the mold thus exposes the working surface 45 of the carbonaceous layer, as shown in FIG. 5d.

Notably, the working surface of the carbonaceous layer was the nucleation surface during its fabrication, and now has a configuration which inversely corresponds to interface surface 60 of the mold, including the small projections 35, which inversely correspond to the concavities 65 of the mold.

Thus a dressing tool of the present invention may include a substrate and a carbonaceous layer coupled to the substrate, wherein the carbonaceous layer has a plurality of small projections which inversely correspond to the configuration or pattern (including a plurality of concavities formed therein) of an interface surface of a mold upon which the carbonaceous layer was formed. As recited above, the shape, size, and placement parameters governing the small projections as disclosed herein must be adhered to, and are expressly applicable to a dressing tool made in accordance with this embodiment of the present invention.

In addition to the devices and methods of fabrication disclosed herein, the present invention encompasses a method for conditioning a fixed abrasive CMP pad. In one aspect, such a method includes the steps of providing a dressing tool as disclosed herein, and applying a working surface, or a portion thereof, against the polishing surface of a fixed abrasive CMP pad, during rotation of the CMP pad. In yet another aspect, the dressing tool may also be rotated, and in a further aspect, the CMP pad may be held still while the dressing tool is rotated.

Of course, it is to be understood that the above-described arrangements are only illustrative of the application of the principles of the present invention. Numerous modifications and alternative arrangements may be devised by those skilled in the art without departing from the spirit and scope of the present invention and the appended claims are

intended to cover such modifications and arrangements. Thus, while the present invention has been described above with particularity and detail in connection with what is presently deemed to be the most practical and preferred embodiments of the invention, it will be apparent to those of ordinary skill in the art that numerous modifications, including, but not limited to, variations in size, materials, shape, form, function and manner of operation, assembly and use may be made without departing from the principles and concepts set forth herein.